THE PLANTS GRAZED BY RED KANGAROOS, *MEGALEIA RUFA* (DESMAREST), IN CENTRAL AUSTRALIA

G. M. Chippendale*

Forest Research Institute, Forestry and Timber Bureau, Canberra, A.C.T.

(Plates VI–VIII)

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Synopsis

A study of the diet of red kangaroos in an area of central Australia shows that grass (75% to 99%) is the preferred fodder, with *Eragrostis setifolia* Nees being the most important single species grazed. Forbs are significantly grazed only for short periods in spring, and trees and shrubs are only grazed in small amounts with some increases in summer.

During drought grazed *Eragrostis setifolia* is higher in moisture content than ungrazed.

A pattern of grazing by kangaroos is suggested from the results obtained, but there is evidence that a larger amount of grazing takes place in gilgais than on the open plain.

Introduction

Preliminary analysis of the diet of red kangaroos, *Megaleia rufa* (Desmarest), in central Australia indicated that green herbage, and in particular the grass *Eragrostis setifolia* Nees predominated (Chippendale, 1962). As Newsome (1965*a*, *b*, *c*; 1966) has shown the supply of green herbage to be vital to the red kangaroo in central Australia, breeding, survival of young, and distribution and abundance depending on it, the plant species grazed by kangaroos in different seasons were studied in detail. The Burt Plain, an important drought refuge for kangaroos (Newsome, 1965*a*), about 32 miles north of Alice Springs, was chosen as a study area.

Habitat

The Burt Plain lies between the Burt and Harry Creeks and is cut by the Stuart Highway (Fig. 1). To the east of the highway, the open grassland varies from *Astrebla pectinata* (Lindl.) F. Muell. ex Benth. communities which were depauperate during the investigation to small water channels and some gilgais carrying *Eragrostis setifolia* Nees and other grasses. To the west of the highway, the grassland is predominantly *Eragrostis setifolia* in and around gilgais, often mixed with *Eragrostis xerophila* Domin. The gilgais had a particular assemblage of other species, including *Swainsona campylantha* F. Muell., *Psoralea cinerea* Lindl., *Neptunia dimorphantha* Domin., *Alternanthera angustifolia* R.Br., *Abutilon malvifolium* (Benth.) J. M. Black, *Centipeda thespidioides* F. Muell., *Marsilea exarata* A.Br., and *Portulaca oleracea* L. Occasional deeper gilgais were almost completely dominated by *Marsilea exarata*. After rains, particularly in summer, annual grasses grew on the plain and in the gilgais.

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* Formerly Animal Industry Branch, Northern Territory Administration, Alice Springs, N.T.

The gilgais are marked depressions into which water runs after rain, and at times (Plate VI) 50 or more points of rain would be sufficient to fill a gilgai. The response of the vegetation to this water was spectacular (Plate VII), with far more growth in the gilgai than on the surrounding open plain.

Tripogon loliiformis (F. Muell.) C. E. Hubbard occurred on the higher parts of the plain after rain, and was most common in the heavy soil area of Cotton Bush, *Kochia aphylla* R. Br.

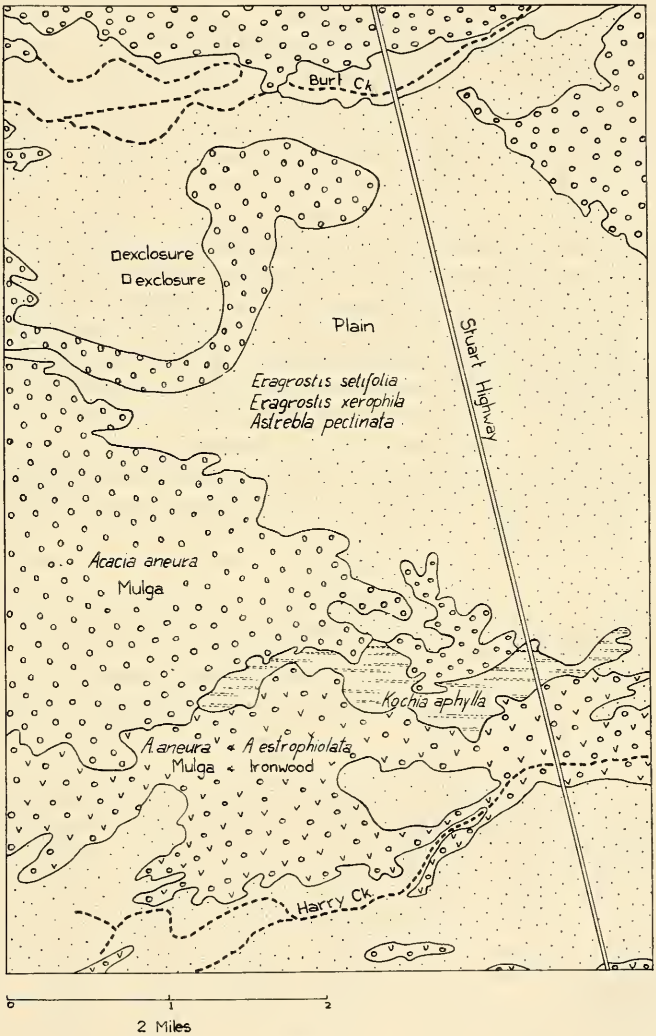


FIG 1.

The grasslands were surrounded by *Acacia aneura* F. Muell. ex Benth. woodland with sparse *Eragrostis eriopoda* Benth. present, and beyond the mulga was the creek bank association with *Eucalyptus camaldulensis* Dehnh., *Eremophila longifolia* (R.Br.) F. Muell., *Santalum lanceolatum* R.Br., *Dichanthium sericeum* (R.Br.) A. Camus, and *Chloris acicularis* Lindl.

The rainfall on the Burt Plain, including for several months prior to sampling, is shown in Table 1.

Cattle were present in small numbers for periods of several months during the investigation.

Methods

Samples from the stomach contents of kangaroos were taken at frequent intervals from October, 1959 to October, 1961, except for five months in 1960, the kangaroos being shot after dark, usually when feeding on the plain west of the highway.

Table 1

Rainfall on the Burt Plain (points)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1959 ..	.. 8	8	155	—	190	6	5	—	1	85	98	53
1960 ..	.. 385	78	—	44	58	9	12	27	61	99	58	52
1961 ..	.. 88	22	—	236	—	—	—	—	—	—	9	—

The samples, approximately 20% of the stomach contents, were washed in a fine sieve, dried in the sun and stored in packets until examined. They were later examined under a binocular microscope on an extension arm, using the point frame method of Chamrad and Box (1964). A frame of crossed threads sat squarely on the dried sample which was spread evenly in a 12″ × 10″ enamel dish. The microscope was used to identify the fragment at each of the 100 points where threads crossed.

Artificial samples containing known percentages by weight were made up by a Technical Assistant and examined by the author who had no knowledge of the contents. Results of the test are shown in Table 2. It can be seen that the accuracy for major constituents is better than for minor constituents, and there is the possibility of missing some minor constituents.

Table 2

Results of test of point frame method, using artificial samples

Species	Quantities (Percentage)							
	1st Test		2nd Test		3rd Test		4th Test	
	Actual	Point Frame	Actual	Point Frame	Actual	Point Frame	Actual	Point Frame
Eragrostis setifolia ..	95·0	95·0	50·0	52·0	80·0	82·75	97·0	99·25
Enneapogon polyphyllus	1·0	3·0	—	—	2·0	5·75	—	—
Portulaca oleracea ..	2·0	0·75	10·0	5·25	2·0	0·75	—	—
Euphorbia drummondii	0·5	0·5	—	—	2·0	2·0	—	—
Salsola kali	1·0	0·75	—	—	2·0	0·75	1·0	—
Acacia aneura ..	0·5	—	10·0	8·75	2·0	0·75	1·0	0·5
Acacia victoriae ..	—	—	10·0	12·75	2·0	1·5	—	—
Tribulus terrestris ..	—	—	10·0	11·0	2·0	0·5	—	—
Atriplex elachophylla ..	—	—	10·0	10·25	2·0	0·5	—	—
Boerhavia diffusa ..	—	—	—	—	2·0	2·75	—	—
Indigofera dominii ..	—	—	—	—	2·0	1·5	—	—

In using the point frame method, four estimates were made for each sample, two each by a Technical Assistant and the author, and the results for each sample averaged.

Fragments were identified by reference to a standard set of plant fragments collected on the Burt Plain, and by checking with authentic specimens in the Herbarium of the Northern Territory, Alice Springs. Owing to the difficulty of identification of grasses from minute fragments, mostly

less than 1·0 mm. long, scores in the point frame were given as "grass" initially, so that only a total grass percentage was obtained. Subsequently, the sample was scanned under the microscope to identify the grass species present and to assess relative dominance, but percentages for individual species were not obtained. Grasses were sometimes identified by portions of spikelets or spikes in the sample, and these in turn were related to leaf or stem fragments associated in same sample. This information provided a guide for identification in those samples in which leaves only were present. When dealing with *Eragrostis* species, which were often present as leaf fragments only, a means of separating these was sought. Examination of the hairs on the inside of the convolute leaves was satisfactory; the angle and arrangement of these hairs varied slightly in *E. setifolia*, *E. xerophila* and *E. eriopoda* (Plate VIII), these being the main species available. Test determination of fragments from herbarium specimens showed about 90% positive accuracy, with the remainder being doubtful; there were no errors.

Fragments of leaves, stems, fruits and seeds in the samples aided the identification of forb and topfeed species, but when there was doubt, specimens were collected from the Burt Plain for comparison.

A number of kangaroo-proof exclosures each five metres square were erected on the Burt Plain; two of these are pertinent to this project, each being on a gilgai. Six transects across each exclosure were each continued for a further five metres outside the fence on two sides; periodic measurements were made of the basal length of any species on each transect. All measurements were reduced to percentage density cover.

After results were known, the moisture content in grazed and ungrazed *Eragrostis setifolia* was measured by weight from monthly samples.

Results

The stomach contents of red kangaroos on the Burt Plain contained some green plant material at all times, though dried basal material predominated in drier periods. This accords reasonably with the results reported by Griffiths and Barker (1966) for Cunnamulla.

Table 3 shows that grass species dominated the diet, almost exclusively doing so during the hot months, representing from 75% to 99% of the plants eaten.

Of 189 samples, 154 contained *Eragrostis setifolia*, and of the remainder, 9 contained *Eragrostis xerophila* and *Tripogon loliiformis*, 9 more contained *Eragrostis xerophila*, 8 more contained *Tripogon loliiformis*, 1 contained *Astreba pectinata* and *Chloris acicularis*, 7 contained mainly an assemblage of annuals, and 1 contained unidentified grass species.

In dry times, such as from October, 1959 to January, 1960, *Eragrostis setifolia* and *Eragrostis xerophila* were grazed by most animals; other species found in the samples in this period were only as traces. With good summer rain, *Tripogon loliiformis* became dominant in the diet in February, 1960.

After little effective rain during the winter, *Eragrostis setifolia* and *Enneapogon polyphyllus* (Domin.) N. T. Burbidge were grazed by most animals during August and September, 1960, but some short ephemeral grasses also contributed to the diet. Moderate rain in September and October caused the diet in early November, 1960 to be mainly *Eragrostis setifolia*, *Eragrostis xerophila*, *Tripogon loliiformis* and *Enneapogon polyphyllus*. By late November and until March, 1961, only dry vegetation was available, and *Eragrostis setifolia* dominated the diet; *Eragrostis xerophila* was commonly grazed in February.

TABLE 3

The quantity of grass and the species contained in samples from kangaroo stomach contents

D=dominant ; C=common ; r=rare

Sample Period	Field Conditions	Number of Samples	Average Quantity (%)	Range of Quantity (%)	Relative Abundance	Perennials							Annuals						
						Eragrostis setifolia	*Eragrostis xerophila*	*Tripogon loliiformis*	*Chloris acicularis*	*Digitaria ammophila*	*Astrebla pectinata*	*Bothriochloa ewartiana*	*Enneapogon polyphyllus*	*Iseilema membranaceum*	*Iseilema vaginiflorum*	*Dactyloctenium radulans*	*Brachiaria gilesii*	*Tragus australianus*	Other Species
1959 13–19 Oct.	Dry basal grass	14	96	92–98	D	6	3	—	1	—	—	—	—	—	—	—	—	—	1
					C	1	3	2	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	1	—	—	2	—	3	—	—	1	—	—	2
11–18 Dec.	Dry grass stems ; water in gilgais	10	96	90–99	D	1	3	—	—	—	—	—	—	—	—	—	—	—	—
					C	2	4	5	—	—	—	—	—	—	—	—	—	—	2
					r	—	—	—	—	—	—	—	—	2	—	—	2	—	4
1960 8–14 Jan.	Dry basal grass ; water in gilgais	7	95	90–97	D	4	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	3	—	3	—	—	—	—	—	—	—	—	—	—	—
					r	—	1	—	—	—	1	—	—	—	—	2	—	—	1
21 Jan.	Green growth in gilgais	10	99	97–99	D	2	2	—	—	—	—	—	—	—	—	—	—	—	—
					C	2	5	5	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	—	1	—	1	—	—	2	—	2	—	—	3
4–12 Feb.	Green	4	99	98–99	D	—	—	2	—	—	—	—	—	—	—	—	—	—	—
					C	2	—	2	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	—	—	—	—	—	—	—	—	1	2	—	2
19 Aug.	Dry	10	75	28–99	D	3	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	7	—	—	—	—	—	—	7	—	—	—	—	—	—
					r	—	—	5	—	—	—	—	—	4	—	4	—	4	—
26 Aug.	Dry	10	88	73–98	D	—	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	10	—	3	1	1	—	—	7	—	—	—	—	—	—
					r	—	1	3	4	3	—	2	—	4	—	8	3	2	3

TABLE 3—*Continued*

The quantity of grass and the species contained in samples from kangaroo stomach contents—Continued

Sample Period	Field Conditions	Number of Samples	Average Quantity (%)	Range of Quantity (%)	Relative Abundance	Perennials: *Eragrostis setifolia*	*Eragrostis xerophila*	*Tripogon loliiformis*	*Chloris acicularis*	*Digitaria ammophila*	*Astrebla pectinata*	*Bothriochloa ewartiana*	Annuals: *Enneapogon polyphyllus*	*Iseilema membranaceum*	*Iseilema vaginiflorum*	*Dactyloctenium radulans*	*Brachiaria gilesii*	*Tragus australianus*	Other Species
1960																			
5 Sept.	Some green	10	85	61–97	D	1	—	—	—	—	—	—	1	—	—	—	—	—	—
					C	5	—	6	1	—	—	—	6	—	—	—	—	—	—
					r	—	—	—	4	2	—	9	—	9	—	8	3	1	1
3 Nov.	Green	10	97	95–99	D	1	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	9	6	8	—	—	—	—	8	—	—	—	—	—	—
					r	—	—	—	2	1	—	3	—	5	1	2	1	—	1
16 Nov.	Drying	10	91	84–98	D	—	—	—	—	—	—	—	1	—	—	—	—	—	—
					C	8	6	5	—	—	—	—	8	—	—	—	—	—	—
					r	—	—	—	1	2	—	—	—	6	5	2	—	—	2
28 Nov.	Dry basal grass	10	92	85–97	D	2	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	8	3	2	—	—	—	—	7	—	—	—	—	—	—
					r	—	—	—	1	—	1	4	—	2	7	3	1	2	2
20 Dec.	Dry	10	97	84–100	D	9	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	1	1	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	3	1	—	2	—	2	2	—	4	2	—	—
1961																			
16 Jan.	Dry	10	94	87–99	D	10	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	2	1	1	—	2	—	2	—	—	1	1	—	—
22 Feb.	Dry	10	96	91–99	D	2	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	8	8	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	3	1	1	—	—	—	—	4	1	2	—	—

TABLE 3—*Continued*

The quantity of grass and the species contained in samples from kangaroo stomach contents—Continued

Sample Period	Field Conditions	Number of Samples	Average Quantity (%)	Range of Quantity (%)	Relative Abundance	Perennials							Annuals						
						Eragrostis setifolia	*Eragrostis xerophila*	*Tripogon loliiformis*	*Chloris acicularis*	*Digitaria ammophila*	*Astrebla pectinata*	*Bothriochloa ewartiana*	*Enneapogon polyphyllus*	*Iseilema membranaceum*	*Iseilema vaginiflorum*	*Dactyloctenium radulans*	*Brachiaria gilesii*	*Tragus australianus*	Other Species
1961																			
29 Mar.	Dry basal grass	10	86	79–95	D	7	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	3	—	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	3	3	—	—	—	—	3	—	—	—	—	—	—
27 Apr.	Green	10	99½	99–100	D	—	—	10	—	—	—	—	—	—	—	—	—	—	—
					C	10	—	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	1	—	—	—	—	—	—	—	—	—	3	1	—
25 May	Green	10	99	98–100	D	—	—	—	—	—	—	—	—	—	—	3	—	—	—
					C	5	—	5	—	—	—	—	2	—	—	7	1	1	—
					r	—	—	—	1	1	—	—	4	9	—	—	7	9	1
22 June	Dry	10	95	85–100	D	1	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	8	—	8	1	1	—	—	—	—	—	—	—	—	—
					r	—	—	—	3	1	—	2	7	9	—	7	7	5	3
29 Aug.	Dry	10	84	70–98	D	2	—	—	—	—	—	—	—	—	—	—	—	—	—
					C	8	—	8	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	—	3	—	—	—	4	10	—	4	4	6	—
24 Oct.	Dry	4	89	80–98	D	3	—	—	1	—	—	—	—	—	—	—	—	—	—
					C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
					r	—	—	—	—	1	—	1	1	3	—	—	1	2	—
Totals	.. ..	189	—	—	D	54	8	12	2	—	—	—	2	—	—	3	—	—	1
					C	100	36	62	3	2	—	—	45	—	—	7	1	1	2
					r	—	8	19	23	12	9	21	26	67	17	50	39	32	25
						154	52	93	28	14	9	21	73	67	17	60	40	33	28

Following the good rain in early April, 1961, *Tripogon loliiformis* predominated in the diet, with *Eragrostis setifolia*. In May, 1961 with no further rain, annual grass species contributed most to the diet, *Dactyloctenium radulans* (R.Br.) Beauv., *Tragus australianus* S. T. Blake and *Brachiaria gilesii* (Benth.) Chase predominating, with *Iseilema membranaceum* (Lindl.) Domin. and *Enneapogon polyphyllus*; seeding heads were common in the samples at this time and *Eragrostis setifolia* and *Tripogon loliiformis* were grazed by fewer animals. In June to August, 1961, *Tripogon loliiformis* and *Eragrostis setifolia* were grazed by almost all animals with annual species being grazed by slightly fewer animals. In October, 1961, the indication is that *Eragrostis setifolia* had again become the main grass in the diet, supported with some annual material.

Table 4 shows that forb species were mostly grazed in small percentages and that the total forbs in the diet only exceeded 10% for short periods. *Calotis hispidula* F. Muell., *Marsilea exarata* and *Portulaca oleracea* were the most consistently recorded annual forbs, and *Helipterum floribundum* DC. tended to become important during the months of August and September. Several other species increased from trace amounts to at least 1% of the diet for brief periods of from one month to several months, and these were *Helipterum charsleyae* F. Muell. (included as "other Compositae") in August, September and October, *Psoralea cinerea* in September, 1960 and March, 1961, *Alternanthera angustifolia* in January to March, 1961. A number of other forbs were consistently recorded as being grazed in trace amounts usually by less than half of the animals sampled at any period, and these were *Euphorbia drummondii* Boiss., *Neptunia dimorphantha*, *Indigofera dominii* Hj. Eichler, *Abutilon malvifolium*, and various *Bassia* species. Other forbs were grazed in trace amounts during isolated periods by few animals.

Table 5 shows that woody species rarely comprised more than 1% of the diet and then only for brief periods. *Acacia aneura* was the predominant tree or shrub species grazed, being recorded in almost all months, but only grazed by about half of the animals. When the amount of this species in the diet increased from trace amounts to 3% in January, 1960 and to 2% in March, 1961, the number of animals grazing the tree also increased, as did the number of tree species being grazed. *Acacia tetragonophylla* F. Muell. was 6% of the diet in October, 1961, after a long rainless period. *Acacia sessiliceps* F. Muell. was grazed as 1% in January, 1961 and 2% in March, 1961 (listed under other species). Other woody species were recorded as trace amounts by few animals or in isolated periods.

Table 6 gives the percentage ground cover in and around two exclosures, and it can be assumed that the cover inside would represent the available fodder on the plain with no grazing while the cover outside reflects grazing as well as an indication of actual available fodder on the plain. Table 6 considered with Tables 3–5 shows that on 16th November, 1960, there were more forbs than *Eragrostis* spp. on the Burt Plain; yet grass comprised 91% of the kangaroos' diet. The diet remained about the same on 29th November, 1960, with available forbs now less than the grass. Grazing of forbs and topfeed was increased on 29th March, 1961, when *Eragrostis setifolia* had been markedly reduced outside the exclosure. Good rains from 10th to 19th April, 1961, resulted in about equal amounts of forbs and grass being available inside, but herbage was less than half the amount of grass outside; the diet at 27th April, 1961 was 99·5% grass with *Eragrostis setifolia* and *Tripogon loliiformis* dominating. Forbs were again more plentiful than grass on 26th May, 1961, but grass was still 99% of the diet, with the annual grasses

TABLE 4

The quantities of forb species identified in samples from kangaroo stomach contents

Sample Period	Number of Samples	Quantity (%)	Average percentage/number of samples in which recorded																					
			Portulaca oleracea	*Calotis hispidula*	*Marsilea exarata*	*Helipterum floribundum*	*Neptunia dimorphantha*	*Lepidium rotundum*	*Alternanthera angustifolia*	*Abutilon malvifolium*	Other Compositae	*Bassia* spp.	*Boerhavia diffusa*	*Indigofera dominii*	*Psoralea cinerea*	*Euphorbia drummondii*	*Sida* spp.	*Tribulus* spp.	*Solanum* spp.	*Goodenia* spp.	Other Leguminosae	*Atriplex* spp.	*Kochia* spp.	Other Species
1959																								
13–19 Oct. ..	14	3	x/1	x/14	1/7	x/8	x/7	x/7	—	—	x/6	x/5	—	—	—	x/3	x/1	—	—	x/1	x/3	x/1		—
11–18 Dec. ..	10	3	x/4	2/10	x/5	—	x/2	—	x/1	—	x/3	x/3	x/4	—	—	x/3	—	x/5	—	x/1	—	—		—
1960																								
8–14 Jan.	7	1	x/1	x/4	x/3	—	x/1	—	x/2	—	—	x/1	—	—	—	—	x/1	x/1	x/2	x/1	—	—		x(1)
21 Jan. ..	10	¼	x/1	x/2	x/2	—	x/1	—	—	—	—	—	—	—	—	x/1	—	—	—	—	—	—		—
4–12 Feb. ..	4	½	x/1	x/1	—	—	x/1	—	—	—	x/1	—	—	—	—	—	—	—	—	—	—	—		—
19 Aug. ..	10	24¾	x/6	x/3	x/1	23/10	—	x/5	—	—	—	—	—	—	—	—	—	1/2	x/2	x/1	x/2	—		x(2)
26 Aug. ..	10	11½	1/7	1/10	x/6	7/10	—	x/3	x/3	x/2	x/3	x/3	x/1	—	—	x/1	x/4	2/2	—	x/1	—	x/1		—
5 Sept. ..	10	14½	1/6	1/8	x/3	4/10	x/2	x/3	x/3	x/3	3/8	x/3	—	x/4	4/3	x/2	x/1	x/1	—	—	—	x/1		x(1)
3 Nov. ..	10	2¾	2/10	x/4	x/2	x/2	x/1	x/5	—	x/2	—	—	—	x/3	—	—	—	x/1	—	x/1	—	—		—
16 Nov. ..	10	8¾	7/10	x/4	x/2	—	x/3	x/1	—	x/4	—	x/1	x/1	x/5	—	x/1	—	—	—	x/1	—	x/1		—
28 Nov. ..	10	7¾	5/10	x/3	x/3	—	x/6	x/1	x/2	x/7	—	x/1	—	x/2	—	x/1	x/1	—	x/3	x/3	x/2	—		—
20 Dec. ..	10	2¾	x/6	x/2	2/6	—	x/2	—	x/3	x/7	x/1	x/1	—	x/2	—	—	—	x/1	x/1	—	—	—		—
1961																								
16 Jan. ..	10	5	3/10	x/3	x/5	—	x/5	x/1	1/9	x/5	x/1	—	x/1	x/3	x/4	—	—	—	x/2	—	—	—		—
22 Feb. ..	10	4	x/7	x/2	1/7	—	1/4	—	1/10	x/4	—	—	x/1	x/2	x/7	—	—	—	—	x/1	—	—		—
29 Mar. ..	10	8	2/10	x/5	1/4	—	—	—	1/6	—	—	x/1	—	x/3	3/8	x/1	—	—	x/3	—	—	x/1		1(3)
27 Apr. ..	10	¼	—	—	—	—	x/1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		—
25 May ..	10	¾	x/4	—	x/1	—	x/2	x/1	x/2	—	—	—	x/2	—	—	—	—	—	—	—	—	—		—
22 June ..	10	4¾	2/9	x/4	x/4	x/2	x/1	x/5	x/5	x/7	—	—	x/1	—	—	—	x/5	—	x/1	x/1	—	—		x(2)
9 Aug. ..	10	15¾	x/1	x/4	1/5	13/9	x/1	x/1	x/2	x/1	1/4	—	x/2	—	x/3	—	—	—	x/1	—	—	—		—
24 Oct. ..	4	4	x/1	x/2	x/1	x/1	x/2	x/1	2/2	—	1/3	x/1	—	x/1	—	—	—	—	—	—	—	—		—
Total number of samples in which species occurred (of 189) ..			105	85	67	52	42	34	50	42	30	20	13	25	25	13	13	13	15	12	7	5	—	9

x = less than 1%.

now being selected by more animals. A similar situation showed on 22nd June, 1961, although the perennial grasses and some forbs were being grazed. By 24th October, 1961, after no rain for six months, negligible amounts of forbs were available on the plain and the perennial grasses were still the dominant items in the diet but forbs represented about 4% of the diet, with topfeed 7%.

Figure 2 shows the amounts of moisture in samples of grazed and ungrazed *Eragrostis setifolia* collected in and near gilgais on the Burt Plain from November, 1963 to January, 1965. Rainfall is also shown. It can be seen that during dry times the shorter grazed shoots contained more moisture than the dry ungrazed grass.

TABLE 5

The quantities of woody species identified in samples from kangaroo stomach contents

Sample Period	Number of Samples	Quantity (%)	Average percentage/number of samples in which recorded				
			Acacia aneura	*Acacia estrophiolata*	*Acacia tetragonophylla*	*Acacia victoriae*	Other Species
1959							
13–19 Oct. ..	14	1	1/11	x/1	x/3	x/3	x/2
11–18 Dec. ..	10	1	x/6	x/6	—	x/1	x/2
1960							
8–14 Jan. ..	7	4	3/6	x/3	x/3	x/1	x/2
21 Jan. ..	10	¾	x/7	x/1	—	—	x/1
4–12 Feb. ..	4	½	x/4	x/1	—	—	—
19 Aug. ..	10	¼	x/3	—	x/1	—	—
26 Aug. ..	10	½	x/5	x/1	—	—	—
5 Sept. ..	10	½	x/4	—	—	—	—
3 Nov. ..	10	¼	x/4	—	—	—	—
16 Nov. ..	10	¼	x/2	x/1	—	—	—
28 Nov. ..	10	¼	x/6	—	—	—	—
20 Dec. ..	10	¼	x/2	—	—	—	—
1961							
16 Jan. ..	10	1	x/3	—	—	x/1	1/4
22 Feb. ..	10	—	—	—	—	—	—
29 Mar. ..	10	6	2/6	—	1/3	1/3	2/7
27 Apr. ..	10	¼	x/4	—	—	—	—
25 May ..	10	¼	x/3	—	—	—	—
22 June ..	10	¼	x/2	—	—	—	—
9 Aug. ..	10	¼	x/3	—	—	—	x/1
24 Oct. ..	4	7	x/3	x/1	6/3	x/2	—
Total number of samples in which species occurred (of 189)			85	15	13	11	18

x = less than 1%.

Discussion and Conclusions

Green grass is the preferred diet of the red kangaroo in central Australia.

Within a month, possibly within several weeks, of effective rain at any time, the diet is almost exclusively grass. Observations at such times have shown that *Eragrostis setifolia* and *Tripogon loliiformis* have soft green regrowth, and this regrowth predominated in the stomach contents. Effective rain in autumn caused annual grasses *Tragus australianus*, *Dactyloctenium radulans*, *Iseilema membranaceum*, *Brachiaria gilesii*, and *Enneapogon polyphyllus* to be grazed by almost all of the animals sampled. These species would probably be grazed after summer rain as they respond in summer.

It is notable that *Eragrostis eriopoda*, which is widely available to the kangaroos in areas of *Acacia aneura*, was not recorded as grazed. Similarly, *Astrebla pectinata* which is available on the open plain, was rarely grazed.

With little effective rain in winter, the forb content of the diet increased to its highest point of about 24% in August, 1960 and 16% in August, 1961. At these times, the rapidly growing ephemeral *Helipterum floribundum* was apparently selected, as high percentages were recorded. Perennial grasses would be in poor condition at this time.

Portulaca oleracea, a succulent annual herb, was particularly selected, although in comparatively small amounts, from November, 1960 to June, 1961. This species, and *Marsilea exarata*, *Neptunia dimorphantha*, *Indigofera dominii*, *Psoralea cinerea*, *Alternanthera angustifolia* and *Abutilon malvifolium* were usually grazed as an assemblage of plants, and as a group, comprised from 1% to about 9% of the diet. As these grow in the gilgais with *Eragrostis setifolia,* it indicates that most grazing takes place in finite areas, the gilgais.

TABLE 6

Percentage cover in two exclosures on the Burt Plain

Date	*Eragrostis setifolia*		Other Species, predominantly Forbs	
	Inside	Outside	Inside	Outside
16.11.1960	4·3	2·7	7·6	7·6
29.11.1960	8·6	6·4	7·8	5·0
20.12.1960	9·8	4·7	20·1	3·5
16. 1.1961	9·2	4·6	7·5	1·3
22. 2.1961	13·1	5·5	20·6	3·6
29. 3.1961	9·3	2·3	3·2	0·2
27. 4.1961	9·9	9·9	9·4	4·4
26. 5.1961	12·1	8·0	21·4	9·2
22. 6.1961	16·1	7·4	21·0	4·9
9. 8.1961	12·2	3·9	9·5	0·7
5. 9.1961	12·6	3·2	5·6	0·4
17.10.1961	11·4	3·8	3·8	0·2
27.11.1961	8·3	2·0	2·1	0·0

The extra water which runs into gilgais makes the grass more succulent, and the moisture content of short shoots of *Eragrostis setifolia* which are grazed ranges from 10% to 20% higher than that of taller ungrazed material of the same species. Although water content was studied several years after the main project, it is likely that similar conditions applied during the project period.

Browse species are unimportant in the diet, for the main woody species eaten, Mulga *Acacia aneura*, only comprised 2% to 3% of the diet during January to March when extra roughage may be sought to balance the soft grass after rain; it was grazed much less at other times. Other browse species were mainly represented as traces. These small amounts would seem consistent with small sporadic grazing in the *Acacia aneura* scrub where the animals mainly rest during the day.

It is concluded that the short green shoots of the perennial grass Neverfail, *Eragrostis setifolia*, in gilgais, was preferred by kangaroos on the Burt Plain as the bulk of fodder all through the year. *Tripogon loliiformis*, which is a perennial with a short growth period and is indicatively known as Five Minute Grass, was also favoured in periods immediately after rain, and

probably as long as green leaf shoots are present. In late winter or early spring, some annual herbage was mixed with the perennial grasses, and in summer the animals select *Portulaca oleracea* with smaller quantities of other annual herbs growing in gilgais. Several annual grasses are selected during summer, and in mid-summer after rain small amounts of topfeed, notably *Acacia aneura*, were eaten. Annual grasses again contributed during autumn.

From this pattern, and from observations, the kangaroo may not seriously affect natural pastures, but certainly grazes the basal portions of perennial grasses in dry times, and in a long drought, this could be serious. Trees are rarely grazed, and no traces of bark or wood were seen in the samples. Field observations confirm that the animals eat the soft regrowth of perennial

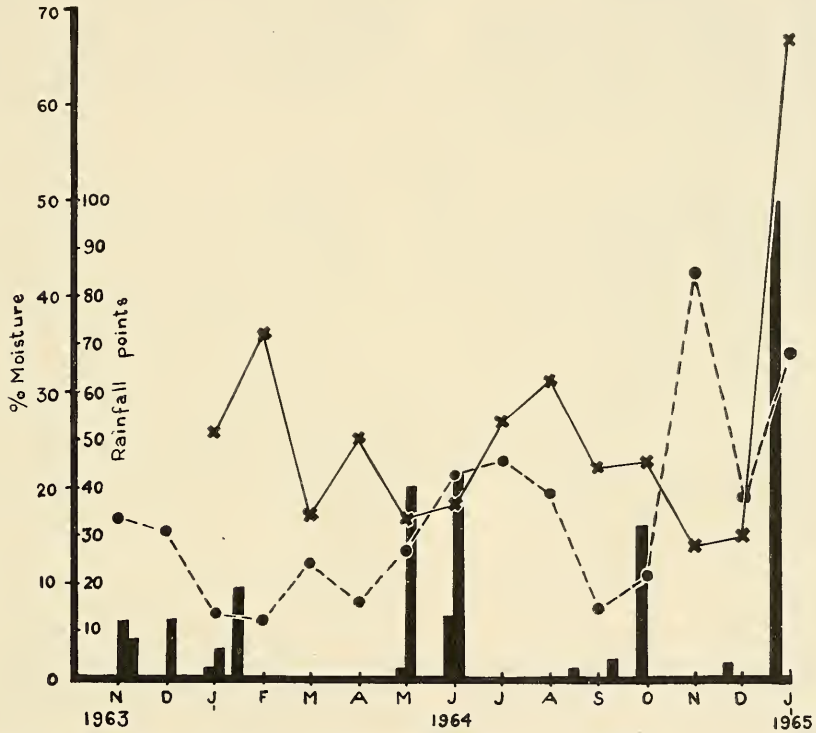


Fig. 2. Moisture contents of samples of *Eragrostis setifolia*: ——— grazed, in gilgais; ----- not grazed, near gilgais.

grasses in gilgais and also graze to a lesser degree other plants which may be green. Similarly, tall grasses are not grazed; it was common to see mature stands of *Eragrostis* spp. on the open plain as ungrazed, while at the same time, tracks, faecal pellets, and signs of grazing in gilgais were common. An explanation seems to be that more or less constant grazing in the gilgais kept the grasses actively growing, and it seems possible that the congregation of faecal matter at these points together with the run-on effect of rainfall may give added recovery power to the grass.

As the perennial grass *Eragrostis setifolia* is the most important single species in the diet of the kangaroo in central Australia, it is possible that this grass in gilgais, and the red kangaroo, may at times form an interdependent relationship.

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EXPLANATION OF PLATES

PLATE VI. An exclosure on a gilgai on the Burt Plain, central Australia, 19th April, 1961.

PLATE VII. The same exclosure and gilgai, 27th April, 1961.

PLATE VIII. Patterns of hairs on inner surface of the convolute leaves of: Top left, *Eragrostis xerophila* from herbarium specimen R. Winkworth 617, right NT313; Centre left, *Eragrostis setifolia* from NT9011, right NT9012; Bottom left, *Eragrostis eriopoda* from M. Lazarides 5189, right N. Burbidge and M. Gray 4544.